US 20020157815A1

(19) United States

(12) Patent Application Publication
Sutter

(10) Pub. No.: US 2002/0157815 A1

(43) Pub. Date: Oct. 31, 2002

(54) **HEAT EXCHANGE TUBING**

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(21) Appl. No.: **09/844,603**

(22) Filed: **Apr. 27, 2001**

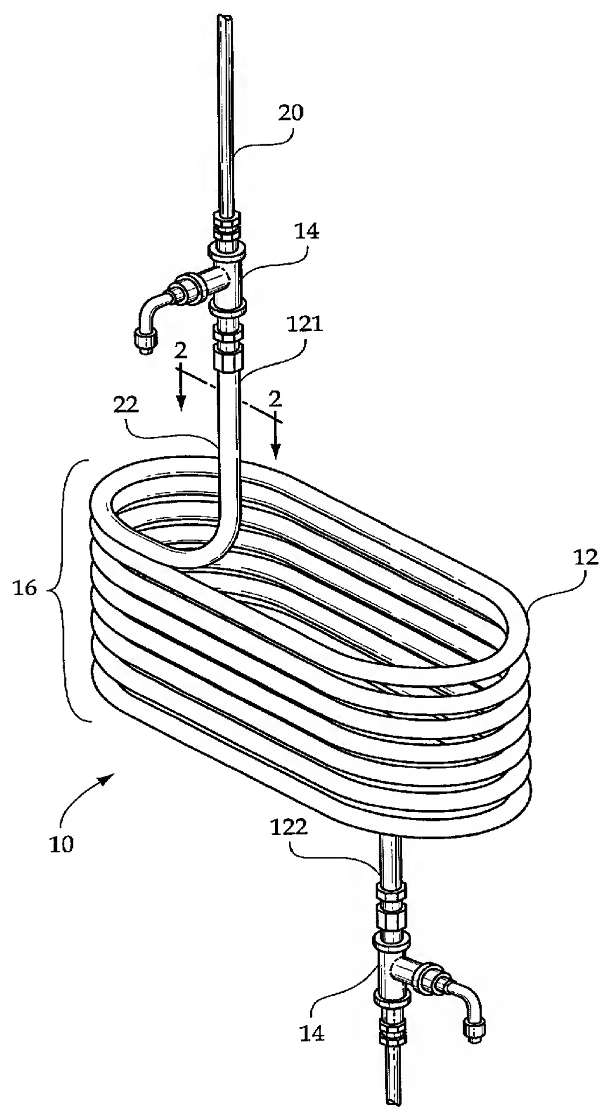
Publication Classification

(51) **Int. Cl.**[7] **F28D 7/10**; F28D 7/12

(52) **U.S. Cl.** **165/154**; 165/156

(57) **ABSTRACT**

A heat exchange device, for allowing the exchange of heat between a first medium and a second medium, using a coaxial double tube. The coaxial double tube includes an outer tube, and an inner tube which extends through the outer tube. The inner tube has an inner conduit for allowing a first medium to travel therethrough, and an outer conduit is formed between the inner tube and outer tube for allowing a second medium to travel therethrough while remaining physically isolated from the first medium. The outer tube is made of plastic, and the inner tube is made of metal, which allows heat to be transferred between the first medium and second medium and allows the tube to be selectively bent into a coil to minimize space for the heat exchange device.



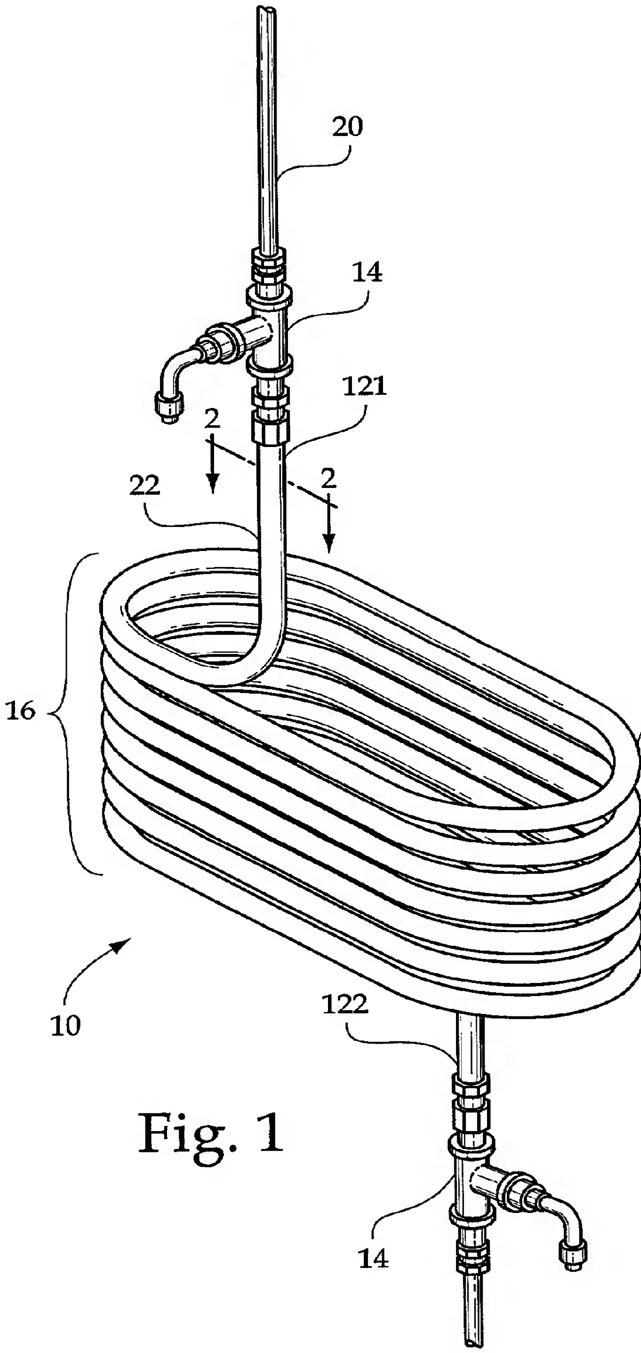


Fig. 1

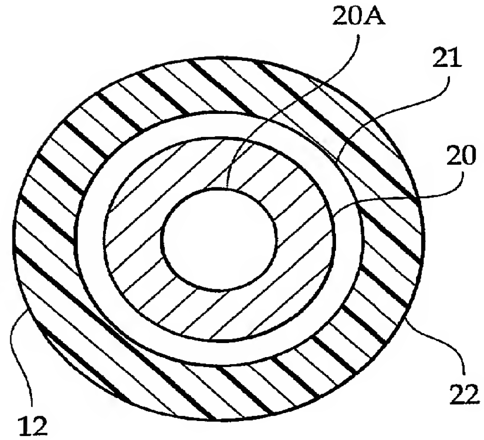


Fig. 2

HEAT EXCHANGE TUBING

BACKGROUND OF THE INVENTION

[0001] The invention relates to heat exchange tubing. More particularly, the invention relates to tubing which allows effective heat exchange between two mediums, while having superior bendability characteristics so that it can be coiled or otherwise formed into a compact configuration.

[0002] A variety of applications require the exchange of heat between two isolated mediums. In the air conditioning and refrigeration field, most systems employ two heat exchangers—an evaporator and a condenser.

[0003] In its most basic form, a heat exchanger can be simply a heat conductive wall between two chambers which each hold one of the two mediums. More typically however, a heat exchanger is formed by a pair of pipes, one pipe often extending within the other pipe such that the outer pipe forms a coaxial tubular jacket around the inner pipe. One medium is pumped through the inner pipe, and the other medium is pumped between the inner pipe and the outer pipe. As both mediums are pumped, heat is conducted therebetween through the heat conductive wall of the inner pipe.

[0004] Other than perhaps the materials employed, the most significant factor then in determining the effectiveness of a exchanger is surface area. Logically, the greater the common surface area contacted by both mediums, the greater the opportunity for heat to transfer between the mediums. Typically then, in a tubular-jacket type heat exchanger, the natural inclination is to increase the length of the heat exchanger.

[0005] Apparently then, if a heat exchanger employs tubing of considerable length, it would require considerable space. The natural inclination then, would be to coil the tubing so as to minimize space. However, coiling a coaxial double tube is not easily accomplished. A coiled double tube cannot be cast or extruded. Accordingly, the only possibility is to form together or combine two straight lengths of tubing, and then try to bend the double tube into a coil.

[0006] Bending such a double tube is not easily accomplished either. Often, an attempt at bending such a precise construction would result in kinking the inner tube, or producing a discontinuity in the small space between the inner tube and outer tube, thus rendering the resulting coil unusable for heat exchange purposes.

[0007] U.S. Pat. No. 4,010,795 to Stenberg discloses a cooling unit in which a coil is formed and maintained using an internal stiffening wire. However, the wire is solid, and thus the tube does not allow two different mediums to flow therethrough in isolation from each other.

[0008] U.S. Pat. No. 4,196,772 to Adamski discloses a tubular heat exchanger in which one tube is spirally wrapped around a tank or reservoir containing an isolated fluid.

[0009] U.S. Pat. No. 4,250,958 to Wasserman discloses a double tubular thermal energy storage element which employs an inner tube and an outer tube. The inner tube allows a fluid to be pumped therethrough. However, the space between the inner tube and outer tube defined by spacers, is filled with a phase change material, and is sealed. Accordingly, Wasserman is not a heat exchanger, but is a heat storage device.

[0010] U.S. Pat. No. 4,893,670 to Joshi et al. discloses an integral radiator hose and oil cooler, which employs a double concentric tube configuration. The tubes are molded together of a polymer material, which allows limited bends to be made, but will not permit three hundred sixty degree bends, or allow for coiling of the tubes.

[0011] While these units may be suitable for the particular purpose employed, or for general use, they would not be as suitable for the purposes of the present invention as disclosed hereafter.

SUMMARY OF THE INVENTION

[0012] It is an object of the invention to produce a heat exchanger which maximizes heat exchange between two isolated mediums using minimal space. Accordingly, the heat exchanger employs a formable coaxial double tubular construction for allowing maximum opportunity for heat transfer between the mediums.

[0013] It is another object of the invention to provide a heat exchanger which is capable of achieving a tightly coiling of its double tubular components. Accordingly, the heat exchanger employs a double tube which is capable of bending without constricting flow within the innermost tube or between tubes.

[0014] It is a further object of the invention to provide a double tube component which is inexpensively manufactured and is reliable in construction. Accordingly, assembly of the double tube involves the simple combination of a metal inner tube and a plastic outer tube. Such an arrangement employs readily available "off-the-shelf" components, and provides the characteristic bendability which allows the other objects of the invention to be accomplished.

[0015] The invention is a heat exchange device, for allowing the exchange of heat between a first medium and a second medium, using a coaxial double tube. The coaxial double tube includes an outer tube, and an inner tube which extends through the outer tube. The inner tube has an inner conduit for allowing a first medium to travel therethrough, and an outer conduit is formed between the inner tube and outer tube for allowing a second medium to travel counterflow therethrough while remaining physically isolated from the first medium. The outer tube is made of plastic, and the inner tube is made of metal, which allows heat to be transferred between the first medium and second medium and allows the tube to be bent into a coil or other suitable shapes to minimize the physical space occupied by the heat exchange device.

[0016] To the accomplishment of the above and related objects the invention may be embodied in the form illustrated in the accompanying drawings. Attention is called to the fact, however, that the drawings are illustrative only. Variations are contemplated as being part of the invention, limited only by the scope of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] In the drawings, like elements are depicted by like reference numerals. The drawings are briefly described as follows.

[0018] **FIG. 1** is a diagrammatic perspective view of a condenser type heat exchanger, employing a coiled coaxial double tube in accordance with the present invention.

[0019] **FIG. 2** is a cross sectional view, illustrating construction of the coaxial double tube.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] **FIG. 1** illustrates a heat exchanger **10**, formed using coaxial double tubing **12**, which comprises an inner tube **20** and an outer tube **22**. The coaxial double tubing **12** has a first end **121** and a second end **122**. In the embodiment shown in **FIG. 1**, the heat exchanger **10** is a condenser. Accordingly a pair of couplers **14** are provided near each of the first end **121** and second end **122**, to allow a cooling medium to communicate with the outer tube. In addition, the coaxial double tubing **12** is formed into a tight coil **16** which allows a relatively long length of the coaxial double tubing to be used in a relatively small space. As illustrated in **FIG. 1**, the outer tube **22** terminates at the couplers **14**, whereas the inner tube **20** extends beyond the couplers **14** where it may be attached to external equipment.

[0021] In the condenser of **FIG. 1, a** condensing medium would typically enter the inner tube **20** from the first end **121** in a gaseous state. The cooling medium would typically enter the outer tube **22** (outside of the inner tube **20**) through the coupler from the second end **122**. Preferably, the cooling medium would counter-flow to the condensing medium and exit the outer tube **22** through coupler **14** at the first end **121**. As heat is transferred from the condensing medium, through the inner tube **20**, to the cooling medium, the condensing medium is condensed into a liquid form.

[0022] **FIG. 2** details construction of the coaxial double tubing **12**. The inner tube **20** is positioned fully within the outer tube **22**, such that an inner conduit **20**A is created fully within the inner tube, and an outer conduit **21** is created between the inner tube **20** and outer tube **22**. Further in accordance with the present invention, the inner tube **20** is made of metal, and the outer tube **22** is made of plastic. Accordingly, the metal inner tube allows heat to be effectively transferred between the inner conduit **20**A and the outer conduit **21**. In addition, the plastic outer tube allows both tubes to be bent together, without diminishing the outer conduit **21**. It should be noted that no spacers are necessary to directly connect the inner tube **20** and outer tube **22** longitudinally. The inner tube **20**"floats" within the outer tube **22**, touching the outer tube **22** at various points along its length, determined in large part by the shape the heat exchanger **10** is formed. However there is no need to physically connect or attach the outer tube **22** and inner tube **20**. Although indirect physical connections might incidentally occur at couplers, such indirect connections along the length of the heat exchanger **10** are not necessary to the integrity of the double tube arrangement.

[0023] Important to the present invention, the heat exchanger is formable into a variety of shapes so that a large contact surface area can be created within a relatively small space. The double tube arrangement of the present invention, using a formable outer tube helps accomplish this goal, by acting as a collar which facilitates bending of the inner tube, without kinking either tube, or blocking the space (outer conduit) formed therebetween. The specified combination of materials, i.e. a plastic outer tube and a metal inner tube, helps provide a heat exchange device which is flexible and formable. It is flexible, in that it is capable of being easily bent more than one hundred eighty degrees. It is formable, in that it will maintain its position once so bent.

[0024] By a preferred embodiment, the inner tube **20** is made of stainless steel. The inner tube **20** may also be made of titanium, aluminum, brass, cupronickel, and other materials with high heat conductive properties. In addition, the outer tube **22** is preferably made of polypropylene plastic, although polyethylene and Teflon, and other formable materials may also be employed. Suitable dimensions for the outer tube include an outside diameter of ½ inch, having a 1⁄16 inch thick wall. Suitable dimensions for the inner tube include an outside diameter of ¼ inch having a ⅓-inch thick wall. Accordingly, the outer conduit is a 1⁄16 inch space which extends on all sides of the inner tube, between the inner tube and outer tube. Adhering to proportions apparent from these dimensions, using an outer tube which has an inside diameter that it 1.5 times larger than the outside diameter of the inner tube would provide results suitable for meeting the purposes of the present invention.

[0025] Depending on the application, the cooler medium may be switched from the outer conduit **21** to the inner conduit **20A** and the hot medium switched from the inner conduit **20A** to the outer conduit **21**. Accordingly, the device may be used equally as effectively for heating, as for cooling. Additionally, this heat exchange can also be applied to simple liquid-to-liquid, gas-to-gas, or gas-to-liquid heat transfer applications where no phase change occurs.

[0026] In conclusion, herein is presented a system for allowing a heat exchanger to be constructed using a compact coil of coaxial double tubing. The coiling can be accomplished because of the use of a plastic outer tube and a metal inner tube. An example of the inventive concepts are illustrated in the drawing figures. However, it should be understood that innumerable variations are possible while still adhering to the principles of the invention. Accordingly, such variations are contemplated as being a part of the invention disclosed herein.

What is claimed is:

1. A heat exchange device, comprising:

an outer tube, having an inside diameter, and made of a flexible, formable material;

an inner tube, defining an inner conduit, the inner tube having an outside diameter which is less than the inside diameter of the outer tube, the inner tube extending coaxially through the outer tube thereby defining an outer conduit between the inner tube and outer tube, the inner tube floating within the outer tube; and

wherein the inner tube is made of metal for transmitting heat between the inner conduit and outer conduit, and whereby the inner tube and outer tube are together flexible and formable without kinking the inner tube, outer tube, and without blocking the inner conduit and outer conduit.

2. The heat exchange device as recited in claim 1, wherein the outer tube is made of a plastic material selected from polypropylene, polyethylene, and Teflon.

3. The heat exchange device as recited in claim 2, wherein the inner tube is made of a metal selected from stainless steel, aluminum, brass, cupronickel, and titanium.

4. The heat exchange device as recited in claim 3, wherein the inside diameter of the outer tube is substantially 1.5 times the outside diameter of the inner tube.

5. A heat exchange device, comprising:

a coil, the coil formed with a double tube comprised of an outer tube, and an inner tube which extends through the outer tube, remaining substantially coaxial therewith throughout the coil, without physical connection between the outer tube and inner tube throughout said coil, the inner tube having an inner conduit for allowing a first medium to travel therethrough, an outer conduit is formed between the inner tube and outer tube for allowing a second medium to travel therethrough while remaining physically isolated from the first medium.

6. The heat exchange device as recited in claim 5, wherein the outer tube is made of a flexible, formable material and the inner tube is made of metal.

7. The heat exchange device as recited in claim 6, wherein the outer tube is made of a material selected from polypropylene, polyethylene, and Teflon.

8. The heat exchange device as recited in claim 7, wherein the inner tube is made of stainless steel.

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